I. RESEARCH PROJECT TITLE

Analysis of Road Condition Data Employing Sensor Fusion and Data Visualization Techniques

II. PROBLEM STATEMENT

Kansas State University – Electrical and Computer Engineering (KSU-EECE) has worked the last year developing an approach for detecting cracks in the roadway using image analysis techniques. As this research has progressed, it has become apparent that the integration of other sources and the display of the results is critical to the effective use of this data. Towards this end it is believed that research into the display of this and related data is needed. The intent of the research would be to facilitate personnel, concerned with overall health of the roadway, to visually inspect the wide range of information available.

III. RESEARCH PROPOSED OR RESEARCH OBJECTIVES

This research is intended to evaluate methods of sensor fusion and the effective display of data. The focus will be on the integration of road bed images and profile data. And the highlighting of important features in that data. Current research is providing the detection of cracking. The intent is to develop approaches and algorithms for displaying the results, and to display other pieces of data along with the image data. The first focus being the integration of image with cracking and height profile data.

IV. ESTIMATE OF FUNDING AND RESEARCH PERIOD

Investigator and Graduate Student Time: $45,000
Proposed time frame: 12 months beginning in June 2007

V. PAYOFF POTNETIAL TO KANSAS DEPARTMENT OF TRANSPORTATION (KDOT)

The KDOT Pavement Management System provides decision support for both Capitol Improvement Project selection and Substantial Maintenance project selection and scope. The KDOT has invested heavily in systems to monitor the health of the roadway infrastructure. The current procedures to collect this data require two passes. One pass is with a profilometer generates measure of roughness, rutting, and faulting. The second pass involves a manual survey for cracking and joint distress. While this manual survey has been effective it does entail some subjectivity in the ratings and requires slow passes on the shoulder or travel way introducing safety concerns. KDOT now owns a data collection vehicle with a profiler and a line-scan imaging camera. The line-scan camera provides images of the road surface. Current research is developing approaches to detect or characterize cracking of the pavement surface in these images intending to replace the existing manual process. The objective of this research is to integrate the various data sets and facilitate its use by KDOT personnel.

VI. IMPLMENTATION STRATEGY

Current research at KSU-EECE on the classification of cracks in images of road beds has lead to a system capable of detecting cracks. The exact statistics of this detection are still being compiled. However during the research two things have become apparent. First is that factors other than the image is needed to properly evaluate the health of the roadway. The first data available is the height profile data. Secondly effectively displaying the results was more of a hurdle that one would expect.

Displayed in Figure 1, are some of the results from the current classification. On the left is the original image, while on the right is an image with regions identified as containing cracks highlighted. Both images are needed since regions that were not highlighted might contain cracks, but they would not be viable. If the scale were reversed then regions containing cracks would tend to not be visible and it would be unclear whether or not they had been misclassified. The introduction of color may seem like a simple solution but it two is problematic. Especially considering which color is to be used with which piece of data.

The previous images show some of the consequences of displaying data and how proper chose of display can greatly enhance its usefulness. If you think this is only the case for images, consider the next display of profile data. In this case the same data is plotted, only a different scale is used for each. Now even though the upper display seems to use a smaller area, the trends in the data can be more easily recognized. This effect can be seen in the traces at approximately 0.4 and 0.8 miles. At these points the upper trace makes the data appear as more of a slope, while the second plot the data looks as if it is a large drop off. Again the human eye can play tricks with data and care must be used to scale and display any data. A common rule of thumb for plotting data is to have the average slope be 45 degrees. The objective of this research will be to automate this scaling.

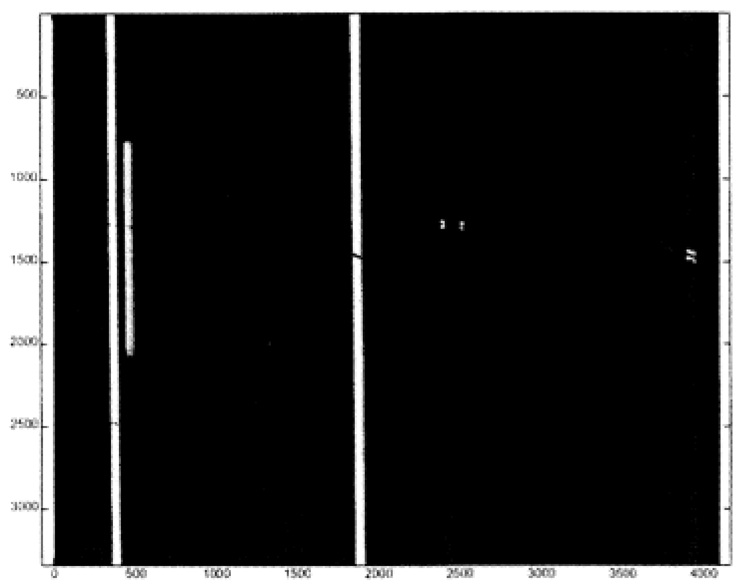

Figure 1. Attempt at Displaying Results of Crack Detection.

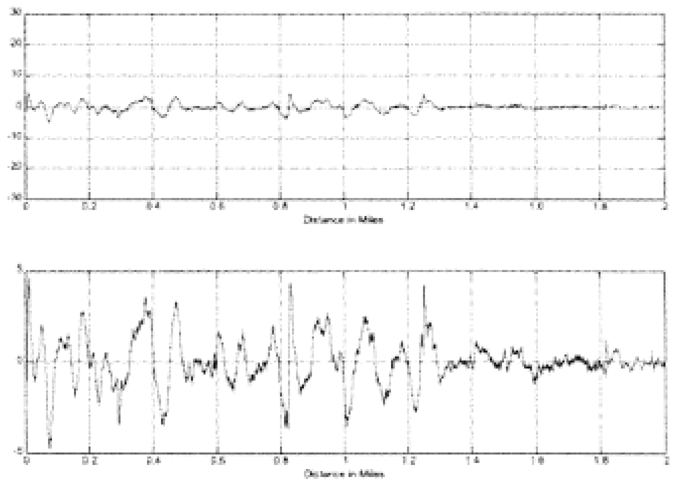

Figure 2. Effect of Scaling on The Display of Profile Data.

With regards to the display of images and profile data, an example of how we will approach this is shown in Figure 3. In this case the image is displayed with simulated traces. Note traces and image should be “stretched” so as to have appropriate data slopes and image aspect ratios. Also of importance is whether the traces should be oriented with “down” being towards the image or is “down” always to the right? In this case we have done what is considered the most natural, which is to have ‘down” is towards the “center” of the image.

It should be noted that many of the terms in the previous paragraph were in quotes, implying that these terms or concepts are subjective in nature. The objective of this research is to objectively define them and create algorithms for implementation. This knowledge and understanding will facilitate the display of not only this data but a range of other such data sets that may be needed.

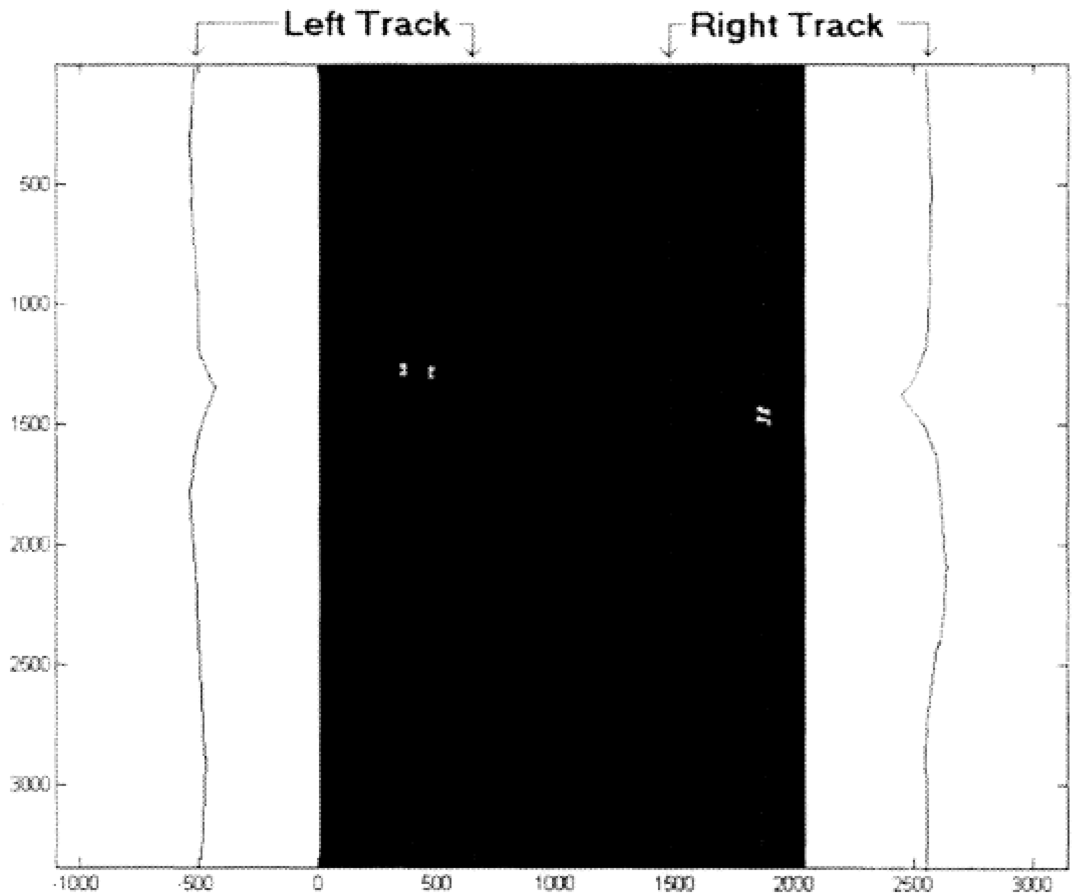

Figure 3. Display of Image with Cracking Highlighted and Height Profile Data Added.

VII. PROJECT PERSONNEL

Kansas State University

Dwight D. Day, Associate Professor, PhD Electrical Engineering, Principle Investigator, Specializes in Digital Signal Processing, Image Processing, and Computer Instrumentation.

Bala Natarajan, Assistant Professor, PhD Electrical Engineering, Co-Investigator, Specializes in Communications, Signal Processing, and Recognition Systems.

Graduate Student Support

VIII. SUBMISSION INFORMATION

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